DOCUMENT RESUME

ED 118 374 SE 020 147

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TITLE JIAFS - A Pattern for Graduate Engineering Education of the Future?
PUB DATE Jun 75
NOTE 23p.; Paper presented at the Annual Meeting of the American Society for Engineering Education (Colorado State University, Ft. Collins, Colorado, June 16-19, 1975)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage
DESCRIPTORS Educational Innovation; *Educational Programs; Engineering; *Engineering Education; *Graduate Study; Higher Education; Program Descriptions; Research; *Research and Development Centers; *Universities

ABSTRACT

A graduate program in engineering at the Joint Institute for Acoustics and Flight Sciences (JIAFS) is described. JIAFS is a cooperative undertaking between the NASA-Langley Research Center and the School of Engineering and Applied Science at The George Washington University. This program adopts a more practical approach than traditional graduate engineering education, providing a combination of applied research and academic studies. (MLH)

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Event Number: 2560

AMERICAN SOCIETY FOR ENGINEERING EDUCATION

ANNUAL CONFERENCE, JUNE 16-19, 1975

COLORADO STATE UNIVERSITY

FT. COLLINS, CO 80521

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SE 020 147

JIAFS - A PATTERN FOR GRADUATE ENGINEERING EDUCATION OF THE FUTURE?

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I. INTRODUCTION

The Joint Institute for Acoustics and Flight Sciences (JIAFS) is a dynamic, cooperative undertaking between the NASA-Langley Research Center (LRC) and the School of Engineering and Applied Science of The George Washington University (GWU) which is dedicated to serving the national needs in scientific research, engineering technology and education. These primary functions of the Joint Institute are achieved by bringing researchers and scholars together at the LRC to exchange their ideas and findings, to give advanced training to graduate students and professional engineers, and to make appropriate use of the extensive research facilities of the Center. This jointly operated institute is a formalization of the interactions between The George Washington University and the NASA-Langley Research Center which began with a graduate education program in 1968.

II. HISTORICAL DEVELOPMENT OF JIAFS

An off-campus graduate study program leading to Master of Science degrees in several engineering disciplines was initiated

by The George Washington University at the NASA-Langley Research Center in the fall of 1968. This program was a result of lengthy discussions and planning between senior officials of the LRC and the GWU faculty, and was set up as a jointly administered venture with both institutions having inputs to its operation. Due to the training policy of NASA, other government agencies and private companies the program was developed primarily for the benefit of part-time students with courses given during the working hours. The on-campus residence requirement was waived for this particular off-campus program. During the first year of this cooperative educational program the faculty was composed of one resident faculty from GWU and 12 part-time faculty which were appointed by the University. The part-time faculty were selected from among the highly qualified research scientists at the Langley Research Center.

During the subsequent years this graduate study program expanded substantially in both participants and scope. The curriculum has been constantly improved as the needs and interests of Langley Research Center and George Washington University changed. After gaining confidence with this new off-campus graduate program, the two institutions felt that even greater benefits could be derived from increased interaction in both research and education. The needs and capabilities of

both GWU and LRC were then considered, and a plan was devised to satisfy the needs of each institution by using the capabilities of both to their maximum advantage.

One of the primary functions of the Langley Research Center is the generation of a large quantity of quality research with a limited number of researchers. Much of this research, of necessity, has become project oriented and, in general, less basic. Conversely, university faculty and graduate students in general perform research of a more fundamental nature. The research conducted by the NASA scientist and that of the university faculty will be complementary if the two researchers recognize both the differences and similarities of their approach to a problem and coordinate their efforts in obtaining a valid solution to the problem. This fact has long been recognized by NASA and has led to the support of many faculty and graduate students across the country.

The university's primary function is education. Continual upgrading of researchers capabilities and training of engineers and scientists in new or different disciplines is a necessity in any research organization. Thus, the university capability - research center need is complementary.

Conducting research on a university campus may be difficult due to a lack of experimental facilities. Certainly this is not the case with a government research establishment such as the NASA-Langley Research Center. In this case the university need is satisfied by the resources of the research center.

There are many research scientists at LRC who are qualified and interested in teaching graduate engineering courses. This is a double-edged resource. On the one hand, it is extremely valuable to have research engineers and scientists teach their specialty to young graduate students, but it may also lead to an 'inbred' research staff if these faculty teach all of the courses. This resource can be used most effectively when an appropriate number of courses in the graduate program are taught by full-time faculty of the university while others are taught by the part-time faculty members. The combined qualities of the faculty will then provide a strong fundamental yet practical graduate education for the young engineer.

Consideration of the factors cited above led to the establishment in the fall of 1970 of a pilot program of research and education in acoustics located at LRC. In this program, which was established with the cooperation of the Institute of Sound and Vibration Research, Southampton, England, a research team consisting of one full-time George Washington University research faculty and four Graduate Research Scholar Assistants (GRSA) joined the GWU faculty already at the Center to form the nucleus for an increased and more responsive interaction with Langley Research Center. The research team worked directly with the NASA acoustics researchers and participated in the graduate study program already at Langley. This pilot program was organized such that both NASA-Langley Research Center and

George Washington University had inputs to all phases of its operation. A similar program of research and education in Flight Sciences was established in 1971, and the Joint Institute for Acoustics and Flight Sciences was formalized later that year. In subsequent years, additional programs in the areas of Structures and Dynamics, Environmental Modeling and Materials Science were added to the JIAFS (Figure 1).

III. ORGANIZATION AND OPERATION OF JIAFS

A programmatic organization of the Joint Institute is shown in Figure 1. Dates in parenthesis indicate the year the program was initiated. Each of these programs is jointly operated by The George Washington University faculty and staff and the appropriate NASA Technical or Training Division. The JIAFS programs may be generally categorized as research, research and education or education programs. The interaction among these three types of programs is evident as might be expected.

The Director of JIAFS is Dr. J. Duberg, Associate Director of NASA-Langley Research Center and the Co-Director is Dr. H. Liebowitz, Dean of the School of Engineering and Applied Science, The George Washington University. Faculty of The George Washington University at Langley and some of the GWU faculty in Washington, D. C.; Graduate Research Scholar Assistants; NASA engineers and scientists who teach part-time and supervise graduate student research; and visiting scientists

and engineers are all members of JIAFS. The Joint Steering Committee advises the Directors of JIAFS regarding basic policy and future plans for the Joint Institute.

Educational Programs

Two types of educational programs are offered by JIAFS. The graduate program, the original interaction between GWU and LRC, has grown and changed over the past seven years as shown in Figure 2.

The areas of study offered at LRC and the particular courses in each area are determined jointly by the GWU faculty and the LRC technical and training personnel involved in the graduate program. Courses must be carefully selected according to the needs of the GRSA in the research and education programs and the part-time students from NASA, other agencies and companies.

Courses offered at LRC in JIAFS must conform to the academic standards of the Department within the School of Engineering and Applied Science which sanctions the course. Consequently part-time faculty are appointed by the chairman of the appropriate department, and faculty meetings are held at both LRC and the Washington campus with the full-time and part-time faculty. This close contact insures that similar academic standards are maintained at the two locations.

Faculty in the graduate program consists of full-time GWU faculty at LRC (each connected with the research and education programs) and approximately fifty NASA scientists and engineers who are teaching on a part-time basis. Both the GWU and NASA faculty serve as thesis advisers and participate on examining committees for the graduate students in the M.S. and D.Sc. programs.

The graduate program was developed originally as a full resident credit program requiring no residence on the Washington, D. C. campus in order to obtain the Master of Science degree. In 1971 the School of Engineering and Applied Science faculty voted to allow, under special circumstances, upon the Department Chairman's approval, the Doctor of Science degree to be completed off-campus. There are currently 20 graduate students in JIAFS pursuing the D.Sc. degree since faculty and facilities are available at Langley to support this level of education in many areas.

Non-degree students make up almost one-third of the student body in the JIAFS graduate programs. These are primarily NASA engineers and scientists who are interested in taking courses to improve their job performance, to stay abreast of a particular field or to retrain themselves in a current area of research, but are not interested in obtaining an advanced degree. They must meet all of the same prerequisite requirements

for taking a course as the degree students, but are not admitted to the School of Engineering and Applied Science for degree study.

Since 1968 the number of courses offered each semester in the graduate program has doubled and the student population has increased by fifty percent. There have been 72 M.S. degrees awarded, and several students in the doctoral program should finish within this year.

In addition to the graduate program at Langley, short courses are also conducted through the JIAFS. These short courses (non-credit) are offered both at LRC and in Washington as the need arises. The courses may have both full-time and part-time faculty presenting lectures on a current area of interest or in a review course tailored to a particular educational need.

Research and Education Programs

The basic objectives of each of the research and education programs, which are funded individually by grants from LRC, shown in Figure 1 are; to conduct research in areas of interest to LRC, GWU and the GRSA; to satisfy the nations needs for graduate level engineers in particular fields; and to provide a full-time educational program at LRC. These unique joint programs attempt to satisfy the needs of both LRC and GWU by using the combined resources and capabilities of each institution. In each of the programs a research unit consisting of a GWU

research faculty and three to five Graduate Research Scholar Assistants work with the NASA researchers on projects of mutual interest. The size of the research unit varies in the programs, but in all cases plans are formulated to graduate and appoint 3-5 new research assistants each academic year. This leads to a stable and continuing program in which some of the students are in their first, second and third year.

The research professor in each unit has the responsibility of determining with the senior NASA researchers which projects his unit will undertake. This is a vital and, at times, difficult proposition. Indeed, the research professor must assure that the proposed research for the GRSA is academically acceptable for either an M.S. or D.Sc. thesis, that his own professional interest is satisfied and that the NASA-Langley Research Center's needs are satisfied by the research project. The research professor performs research individually and with the NASA scientists while supervising the research of his GRSA and, possibly, NASA part-time students. In addition to his research and informal consulting with the NASA scientists, the GWU faculty presents one lecture course each semester in the graduate program previously described.

The Graduate Research Scholar Assistants are also involved in the graduate program since they take two to three courses each semester until their degree course requirement is met. Each GRSA is assigned a GWU research faculty adviser and a NASA

adviser upon his arrival to JIAFS. This joint advising further insures that both NASA's research needs and the needs of the GRSA and the university for an acceptable thesis are met. The research assistant conducts research half time during the academic year and full time during the summer. He receives a stipend from the University which enables him to pay his tuition and living expenses. These positions are similar to a research assistantship on any campus except that the GRSA in JIAFS receives two somewhat different types of guidance. One of these comes from his GWU faculty adviser while the other comes from his NASA adviser. Normally a minimum of two years is required to obtain a Master of Science degree and three years additional study past the M.S. are needed for the D.Sc. degree.

Appropriate research facilities of the Langley Research Center are made available to each of the research units for both faculty and graduate student use. Most of the faculty and GRSA are collocated with their NASA counterparts in the facilities where their research is conducted. The computer center and library are used by almost all of the faculty and GRSA.

Research Programs

In addition to the research performed by the GWU research faculty and GRSA under the Research-Educational Programs, other research projects are undertaken through an unique research program which has been established for visiting scientists and engineers.

The Visiting Members Program provides a mechanism for post-doctoral or senior researchers to spend up to two years at LRC conducting research in the NASA facilities in conjunction with NASA scientists and GWU faculty. The Research Scientist or Engineer may also be permanent full-time positions in JIAFS which are totally research oriented. The Research Scientist may supervise graduate students, but in general does his own research only. These positions provide JIAFS, and thus GWU and NASA, with transient inputs to the ongoing research and educational programs.

All of the JIAFS programs are reviewed annually by the Langley Research Center and The George Washington University. Senior members of both institutions then jointly assess the progress of the programs, recommend changes as necessary and suggest new directions for further development of JIAFS. The current and projected (1975-1976) complements of JIAFS are shown in Figure 3.

IV. RESULTS OF THE JOINT PROGRAMS

The consequences of the many and varied interactions between The George Washington University and the NASA-Langley Research Center in the JIAFS may be categorized as research or educational results. There are obvious benefits and potential problems in each category for the graduate student, NASA-Langley Research Center and George Washington University.

Educational

Courses in the graduate program taken by the GRSA combine practical experience with academic education. Most of the classes are composed of students with varied backgrounds (GRSA, government employees, private company employees) which tend to make discussions lively and the classes more interesting. The courses are taught by faculty members who are generally conducting state-of-the-art research in the course area.

Each of the graduate students must be counselled, however, to pursue a broad course of study even though his current research field is narrow. This problem of students obtaining an overly focused educational background due to the necessity of solving a particular research problem arises at many universities and may be minimized by faculty guidance.

Educational benefits to the Langley Research Center are primarily the retraining and advanced training of its research staff by an outstanding faculty composed of a combination of full-time and part-time instructors. In addition, the NASA scientists through teaching and supervision of students in the graduate program continue to improve their own research capability as well as their students. The presence of George Washington University faculty and visiting scientists at LRC insures that the program does not become stagnant and helps avert the inbreeding problem. Since JIAFS is jointly operated,

the educational programs are responsive to the changing educational needs of both the Center and the University. In addition, the availability of a strong graduate program on site is an excellent recruiting aid for the center.

The potential problem of inbreeding, i.e. all or most engineers obtaining their advanced training from one university or faculty, must still be considered. Certainly the temptation to obtain an advanced degree without leaving the area is strong. It remains for the senior members of LRC and GWU to suggest off-center university programs when they are more suited to the students needs.

The University's educational programs at Langley Research Center and in Washington, D. C. are expanded and continually updated through the interactions in the JIAFS. Faculty of the University are brought into contact with the NASA researchers teaching in the program with the resultant exchange of ideas, course outlines and teaching techniques.

Maintaining broad, basic academic courses in addition to specific job-oriented courses is one of the most important responsibilities of the university in JIAFS. In almost any research organization the interest of most staff and line supervisors is strongest in narrow courses aimed at the particular research problems the organization is currently attacking. While it is recognized that these are valuable courses for the near term, the university must, and does, recognize

also that research interests change with time, and thus, that a graduate program must be composed of both basic and applied courses to help insure the students' success in the future.

Research

Graduate students in engineering are afforded the opportunity as GRSA of participating in "real world" research problems guided by both a NASA engineer and a GWU faculty. He may use the most current research facilities, both analytical and experimental, for his thesis project. The student associates daily with experienced engineers and scientists as well as fellow graduate students and faculty, and thereby, gains a professionalism not ordinarily obtained on a university campus. Most of the students have the results of their research presented or published by the time they complete all degree requirements. When the GRSA graduates with a Master of Science degree he will have more than a year's experience as a researcher, and will be familiar with the current research techniques in his chosen area of interest. The doctoral student will be even more familiar with his professional area after three years of study and research.

On the other hand, the graduate student must channel his research interests to those of the Langley Research Center. This potential problem is not really any more restrictive than

on most campuses where there a limited number of faculty and hence only a limited range of research projects for the student to pursue.

The NASA-Langley Research Center obtains research output from the JIAFS from the GWU faculty, the visiting scientists and the GRSA. Indeed, the research that is done in the joint programs is directly applicable to NASA's needs since each research project is discussed and outlined with both GWU and LRC scientists prior to being undertaken by a member of JIAFS. In addition, the NASA engineers participating in the graduate program at LRC produce essentially the same research while pursuing their graduate degrees as they do in full time work status. The benefits to the Center's research under this arrangement have been demonstrated.

Since most of the programs in JIAFS are for both research and education activities, the Center might not obtain quite as much research output from the JIAFS as it would if the programs were entirely research oriented. In spite of the extensive educational activities in JIAFS, the research conducted by the faculty, visiting members and research assistants has led to the publication or presentation of 104 technical papers in areas of research which are directly applicable to NASA's needs.

The George Washington University's research activities are increased greatly by the JIAFS programs. New areas of research are introduced to the faculty and more applied research problems are suggested by the LRC engineers to the faculty as

possible thesis projects. The University's stature in both the educational and research fields is increased by the research output of the joint programs.

A potential difficulty for The George Washington University faculty at Langley is that the areas of research are restricted to those which NASA pursues. Fortunately a certain latitude for the faculty's research is available since NASA's interests are widespread. After becoming aware of the areas of research at Langley the University faculty has the opportunity and responsibility of suggesting new research projects to LRC in addition to participating in the on-going research.

The benefits from these programs as discussed above are many, and the potential problems appear to be, and in general have been, manageable. When these difficulties are overcome, the benefits of the JIAFS and similar programs include research results in areas of national need and the training of highly qualified engineers who become a pool of technical talent from which the nation may draw its future engineering leaders.

V. POTENTIAL OF JIAFS-TYPE PROGRAMS

Basically JIAFS is a university/research agency interaction in which the historical prerogatives of each agency have been preserved, but which permits, even requires, input to these prerogatives from the other institution, and thereby attempts to use the best capabilities available for graduate engineering

education and research. Some of the benefits and problems associated with this type of cooperative venture have been discussed previously. What then are the possibilities for similar programs to develop in the future?

The requirements for this type of program are, basically, a university that is willing to discard the "ivory tower" concept and adopt a more practical approach to graduate education, and a research organization with modern facilities which is interested in upgrading its staff and supporting university research. The former requirement is becoming fairly commonplace. Many if not most universities recognize the necessity for engineers to have practical experience as well as strong academic backgrounds, and have begun recently to reemphasize the more applied aspects of engineering. A research agency or major company is almost always interested in providing advanced training opportunities for its employees, but with restricted funding and tight budgets, it has become necessary for educational costs to be as low as possible and the research or production output of the agency as large as possible. In many cases it may be less expensive to establish a university type program on-site than it is to take a number of engineers off the job and send them to graduate schools elsewhere particularly when the increased research output obtained from the faculty-graduate research assistant unit is considered.

If a university and a research agency can cooperate closely the problems that arise for each in this type of joint arrangement can be overcome. The benefits to all involved in these programs are many, and since limited funds are available for construction of new facilities, new faculty appointments, performance of research, and graduate education in general, it appears that these joint education and research programs, as developed in the JIAFS, do indeed offer a viable option for graduate study in the future.

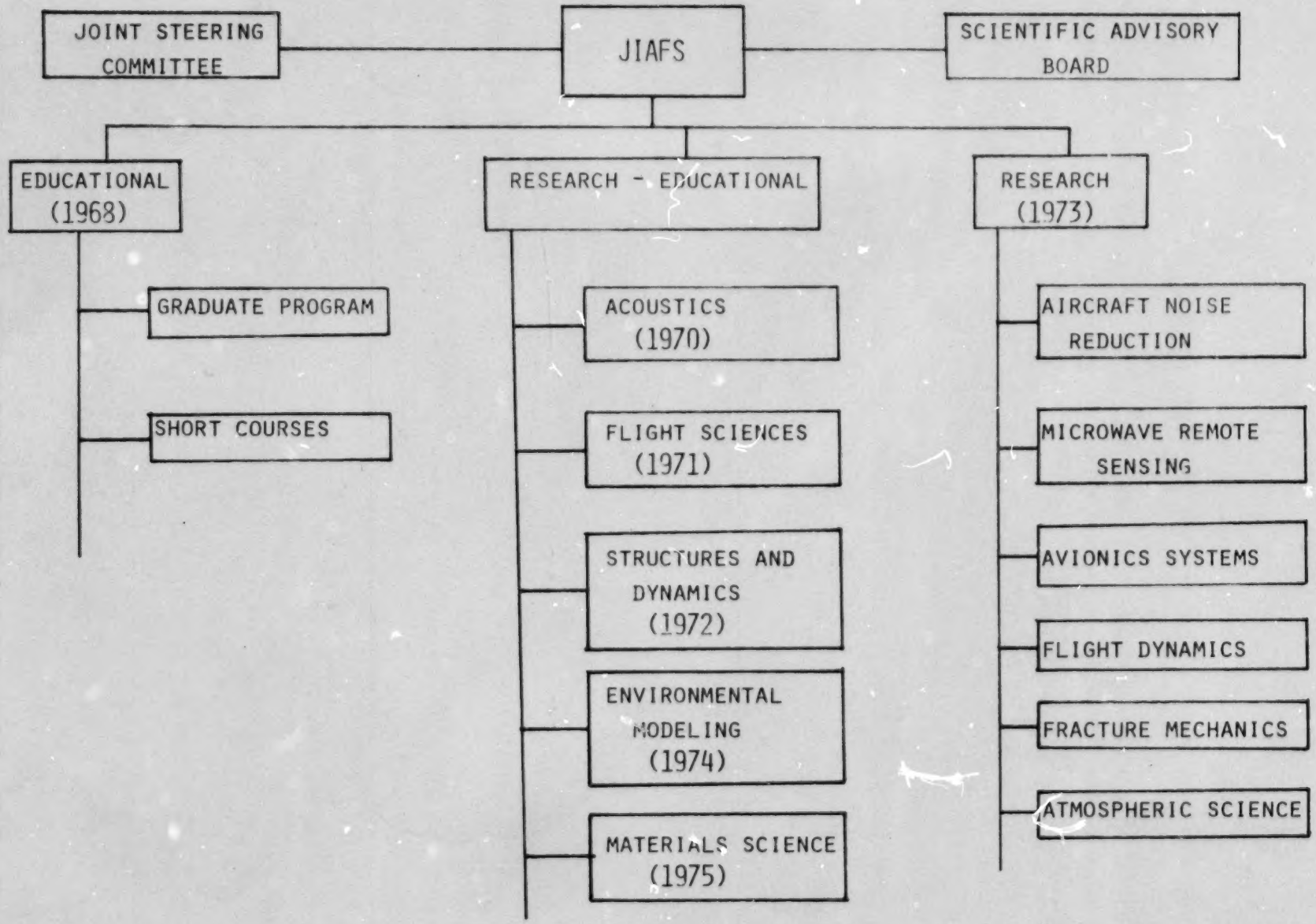

FIGURE 1. JIAFS ORGANIZATION

	FALL 1968	FALL 1974	FALL 1975 (PROJECTED)
NUMBER OF COURSES	12	24	28
NUMBER OF STUDENTS	114	167	175
NUMBER OF REGISTRATIONS	148	226	240
STUDENT BODY			
NASA	109	110	110
GRSA	-	27	30
OTHER	5	30	35
FACULTY			
FULL-TIME	1	9	9
PART-TIME	25	50	55
DEGREES AWARDED TO DATE	-	50	72

FIELDS OF CONCENTRATION

- ACOUSTICS
- FLIGHT SCIENCES
- STRUCTURES & DYNAMICS
- ENVIRONMENTAL MODELING
- MATERIALS SCIENCE
- FLUID MECHANICS
- THERMAL SCIENCE
- SOLID MECHANICS
- ELECTRICAL ENGINEERING
- COMPUTER SCIENCE

FIGURE 2. GRADUATE PROGRAM

	FACULTY		RESEARCH ASSISTANTS		STAFF		VISITING MEMBERS	
	CURRENT	75-76	CURRENT	75-76	CURRENT	75-76	CURRENT	75-76
GENERAL	1	1	-	-	1	2	1	2
ACOUSTICS	3	2	7	8	-	-	3	3
FLIGHT SCIENCES	1.5	1.5	8	10	-	-	-	1
STRUCTURES AND DYNAMICS	2.5	2.5	3	7	1	2	-	-
ENVIRONMENTAL MODELING	1	1	1	5	1	1	-	3
MATERIALS SCIENCE	-	1	-	5	-	1	-	1
	9	9	19	35	3	6	4	10

CURRENT STAFF - 35 MEMBERS

1975-76 PROJECTED STAFF - 60 MEMBERS

FIGURE 3. JIAFS FULL-TIME COMPLEMENT AT LRC